REMARKS

Claims 23-29 & 34-36 are now in the application. Reconsideration of the claims as amended and added above is respectfully requested.

In the Office action of October 27, 2003, claims 1-7 & 21 were withdrawn from consideration as being directed to a non-elected invention. Also, a new Declaration by the inventor, claiming priority of his Provisional Application No. 60/254,751 (filed December 11, 2000) was required. A new declaration signed by applicant and complying with the requirement is provided herewith.

FIG. 1 of the drawing was objected to for omitting the legend "Prior Art". By separate Letter to the Official Draftsperson filed concurrently, applicant respectfully requests the Examiner to approve proposed corrections to his original FIGS. 1 and 2, and a proposed new FIG. 3 that illustrates various steps of his presently claimed electrical contact treatment method. No new matter has been introduced.

The specification was objected to for containing several informalities. See Office action, pages 3-4. Applicant respectfully submits that the within amendment to the specification meets the various objections raised by the Examiner. Applicant also notes that the temperatures "150F & 250F" recited at page 10, line 10 have been corrected to read 150 degrees C and 250 degrees C, respectively, and that other inadvertent typographical errors at pages 10 and 11 wherein temperatures were incorrectly stated as being in degrees F rather than in degrees C, have been corrected. Support for the correction is found, for example, at page 5, lines 20 and 22 which state that aging of samples was performed at temperatures of 125 degrees C and 150 degrees C, and by the common practice in the art to disclose such temperatures in terms of degrees Centigrade.

Applicant's cooperation was requested in correcting any other errors in the lengthy specification of which he is aware. The specification has been thoroughly reviewed and a number of informalities, including those noted above, have been corrected. No new matter has been introduced.

Claims 22, 33 and 35 were objected to for improper wording, and corrections were suggested at pages 4-5 of the Office action. The claims as now amended and added meet the various objections raised by the examiner.

Claims 26-29 were rejected for containing indefinite terminology, per 35 U.S.C. § 112. Office action pages 5-6. The claims as now amended and added meet the various informalities that were raised by the examiner.

Claims 22-24, 26, 31 & 32 were rejected as anticipated by a published article by Chow et al., entitled "Interdiffusion of Cu substrate/electrodeposits for Cu/Co, Cu/Co-W, Cu/Co/Ni and Cu/Co-W/Ni systems". Office action, pages 6-7. Also, claims 25, 27-29 & 33-35 were rejected as being unpatentable over Chow et al., and claims 22-26 & 30-35 were rejected as unpatentable over JP 56-154261. Further, claims 27-29 were rejected for being unpatentable over JP '261 in view of Chow et al. Office action, pages 8-13.

Claim 22 is now canceled and is substituted by new claim 36, the latter being the only independent claim in the application. Claims 30-33 are also canceled, and remaining claims are amended to depend directly or indirectly from new claim 36. The following remarks demonstrate that the pending claims define a treatment method for an electrical contact member that is not disclosed or suggested by the cited art.

The Present Invention

Applicant's method obtains superior contact resistance performance for an electrical contact member made of copper or an alloy of copper. That is, a contact member treated according to the invention will exhibit minimal contact resistance over time in a high temperature environment. A typical contact member such as shown in FIG. 1 of the present application, consists of a copper alloy substrate, a barrier layer, and a finish layer which is typically a tin alloy or a noble metal such as gold, Pd, and the like. During use, the electrical contact resistance of the connector system (copper substrate + barrier layer + finish layer) increases and the performance of the contact member degrades with time, especially in a high temperature environment.

Degradation of the contact resistance of the connector member may result from several factors, such as:

1. Diffusion of substrate Cu to the outer surface leading to oxidation of Cu and formation of intermetallic compounds with the finish layer, Sn or Au. Intermetallic compounds generally have higher resistivities.

2. Alloying of the finish layer with the barrier layer and formation of intermetallic compounds resulting from the reaction between the barrier layer and the finish layer. Both reactions lead to higher contact resistance values.

3. Oxidation of the barrier layer resulting from the diffusion of oxygen through the finish layer.

Thus, sample contact members are generally aged at 150 degrees C in air and their contact resistance is measured to demonstrate an acceptable resistance performance of, preferably, less than 10 milliohms. Applicant's claimed method obtains

superior contact resistance performance for an electrical contact system (copper substrate + barrier layer + finish layer) as compared to prior art systems which use a nickel-base barrier layer.

Specifically, new claim 36 calls for electroplating a barrier layer on a contact surface of the member, wherein the barrier layer is selected from cobalt and certain cobalt alloys. The barrier layer is formed to a thickness in the range of about 0.00001 inch to about 0.0001 inch, and which is sufficient to prevent the contact resistance of the treated contact member from increasing above a given limit over a given period of time at a given temperature.

An outer finish layer is coated over the barrier layer, and the finish layer is selected from among alloys of tin (e.g., Sn/Pb) and certain noble metals, so that the given limit of electrical contact resistance of the treated member is about 10 milliohms, the given period time is at least 1,000 hours, and the given temperature is at least 150 degrees C.

The Cited References

Chow et al. is directed to interdiffusion of Cu through Ni, Co and Co-W, and is silent with respect to any resulting contact resistance of a typical connector system. As mentioned, contact resistance is affected not only by the extent to which Cu diffuses to the surface through a barrier layer, but it also depends on interactions between the barrier layer and the finish layer, and oxidation of the barrier layer itself. Simply reducing interdiffusion of Cu as taught by Chow et al. may not always result in a lower contact resistance. For example, while a thicker (e.g., more than 50 micro inch) nickel barrier layer might be very effective to minimize interdiffusion of Cu through the barrier layer, it would also increase the overall contact resistance by reacting with the finish layer (e.g., by alloying and forming intermetallic compounds).

Further, Chow et al. characterizes interdiffusion of Cu in a temperature range of 400 to 800 degrees C which is significantly higher than temperatures used to evaluate electrical resistance performance of contact members, namely, about 150 to 200 degrees C. Exposure temperatures can significantly change complex metallurgical reactions, including the interdiffusion of Cu. Chow et al. observes that nickel becomes more effective as a barrier between 600 to 800 degrees C compared to Co and Co-W. Thus, any enhanced performance of Co as a barrier layer compared to Ni at 400 to 600 deg. C as observed by Chow, cannot be extrapolated reliably to apply at temperatures of around 150 degrees C.

Accordingly, Chow et al. do not teach or suggest treating a contact member by forming a barrier layer to a thickness in the range of from about 0.00001 inch to about 0.0001 inch and which, after coating, is sufficient to limit electrical contact resistance of the treated contact member to less than 10 milliohms over a period of at least 1000 hours and at a temperature of at least 150 degrees C, as presently claimed. Withdrawal of Chow et al. as a rejecting reference is therefore respectfully requested.

JP '261 relates to coating of molds for casting molten metals, with a thick (400 micro inch to 12,000 micro inch) coating layer of Ni-W-Co-P. While such a coating on copper molds may exhibit superior heat resistance, mold erosion resistance, heat cracking resistance and the like; none of these characteristics pertains to achieving superior electrical contact resistance (e.g., less than 10 milliohms) at exposure temperatures of 150 to 200 degrees C, as presently claimed.

In view of all the foregoing, the pending claims call for a method of treating a copper electrical contact member that is not disclosed or suggested by the cited references, whether considered alone or in any combination with one another. Allowance of the claims and passing of the application to issue are respectfully solicited.

Respectfully submitted,

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